TRITON ENGINEERING SERVICES LIMITED
Consulting Engineers

105 Queen Street West, Unit 14
Fergus
Ontario N1M 1S6
Tel: (519) 843-3920
Fax: (519) 843-1943
Email: info@tritoneng.on.ca

ORANGEVILLE • FERGUS • HARRISTON

June 24, 2021

RE: TOWNSHIP OF SOUTHGATE
NEW ELEVATED MUNICIPAL DRINKING WATER STORAGE FACILITY
PRELIMINARY DESIGN REPORT
DUNDALK, ONTARIO
OUR FILE: T4612A
DWWP No.:110-201

Dear Riaz ul Haq,

On behalf of the Township of Southgate, we are pleased to provide the following preliminary design report in support of the construction of a new municipal drinking water elevated storage facility (water tower) to service the Community of Dundalk, Ontario.

Background Information:

Existing Water System

The Dundalk municipal drinking water system (the system) consists of three (3) groundwater wells, three (3) ground level water storage reservoirs currently being used a chlorine contact tanks (CCT) and approximately 19 kilometers of distribution watermains. The system is currently owned and operated by the Corporation of the Township of Southgate, under Drinking Water Works Permit number 110-201 (attached). The water tower is proposed to improve the level of service to the community, including an increase in water available for fire-fighting, increased reliability in system pressures and more efficient use of pumping equipment.

The existing Dundalk system is supplied by grade level storage facilities located at the existing well houses, as indicated in Table 1 below. As there is no elevated storage facility, pressure within the system is maintained by continuous pumping and fire flows must be achieved through the use of a large diesel fire pump. This mode of operation has several disadvantages as follows:

- Continually running of pumps, even when system demand is negligible, results in wasted power usage and excessive wear on pumping equipment.

- Relying on the pumps to maintain a consistent operating pressure at a wide range of demands results in pumps not running efficiently much of the time and requires complicated control of the various pumps.
- Having an elevated storage volume allows pumps to be run during off peak times when hydro rates are lower.
- Utilizing a large pump to meet fire demands results in additional maintenance as this pump needs to be run/maintained regularly so it is available at any time. Further, this system is not typically automatic, it requires operator intervention to ensure it performs adequately during a fire condition. This intervention requirement can result in delays in delivering adequate fire flows at critical times.

As indicated by the MOE guidelines, storage facilities (D4 and D5) that are designed for treatment (i.e., Chlorine Contact) are not typically to be included in the storage volume requirement calculations. As such, system storage is currently provided by a on-grade reservoir located adjacent to Well D3. This storage is available to the system using a large diesel-powered pump that provides fire flows when required. This pump is expensive to maintain and operate. Therefore, the intention is to decommission the fire pump and only use the storage tank as a chlorine contact tank for treatment.

However, suitability of the continued use of this storage tank will need to be assessed since it may be preferable to decommission the existing tank/system entirely and replace it with a new CCT. The intent is that all other storage facilities (D4 and D5) will remain in service as is required for treatment.

Table 1 – Existing Storage Facilities

Operating Volume			
D3 (m^3)	**D4** (m^3)	**D5** (m^3)	**Total** (m^3)
1,306	188	540	2,034

Class EA Status

The concept and need for an elevated tower were previously identified within the Schedule B Municipal Class EA completed in conjunction with the addition of Well D5.

<u>Service Area & Population:</u>

Based on projections provided by stakeholders (Township & County) and senior municipal representatives, the expected growth of residential units, and the equivalent thereof (ERUs), within Dundalk is going to continue at a rate of 150 units for the next 5 years (2020 – 2025) and then 120 units for the following 20 (2026 – 2046), resulting in a total growth of 3,150 units by the end of year 2046. Growth beyond the year 2046 is expected to continue at an average rate of 2% until the 50-year planning horizon (2073) is achieved. Therefore, growth has been estimated up to the year 2073 as the water tower is expected to be in operation by the beginning of 2023 (i.e., 50-year horizon). Refer to Table 2 below for additional information.

Table 2 – Population Growth Forecast

Year	**Growth Assumed**	**New Equivalent Residential Units** (ERUs)	**Total ERUs**	**Population** (Capita)
2020	Existing	Existing	1,067[1]	2,774
2025	150 ERUs/year	750	1,817	4,769
2030	120 ERUs/year	600	2,417	6,365
2035	120 ERUs/year	600	3,017	7,961
2040	120 ERUs/year	600	3,617	9,557
2045	120 ERUs/year	600	4,217	11,153
2050	2% Annualized growth	439	4,656	12,320
2055	2% Annualized growth	485	5,140	13,610
2060	2% Annualized growth	535	5,676	15,033
2065	2% Annualized growth	591	6,266	16,604
2070	2% Annualized growth	652	6,918	18,339
2073	2% Annualized growth	423	7,342	19,465

[1] As reported in the Dundalk Waterworks 2020 Annual Report (attached for reference).

<u>Site Location</u>

The proposed water tower site location was previously selected during the Schedule B Municipal Class EA completed in conjunction with the addition of Well D5. The selected site is located on existing Municipal Property at the Well D4 site, located at 550 Main St East in Dundalk (NAD 83, Zone 17, +/- 10 m, 549154 m E, 4891748 m N). Refer to Figure 1 below and DWG 01 attached.

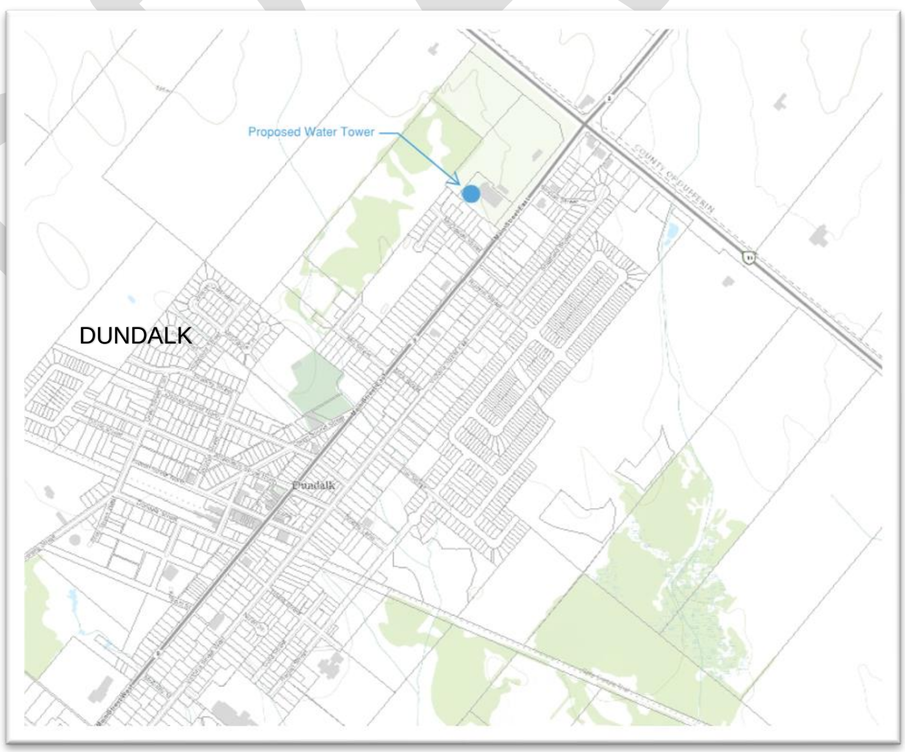


Figure 1 – Site Location

Water Demand & Fire Flow

Maximum and Average Day Demands

The existing historic 3-year; Maximum Day Demand (MDD), Average Day Demand (ADD) as reported in the annual Reserve Capacity (RC) Calculations (attached) and the populations as described above results in the following expected future domestic and/or Industrial, Commercial, Institutional (ICI) demands. It is understood that the Township will allocate RC to both residential and ICI developments based on expected demands and it is therefore appropriate to calculate expected demands based on the equivalent population presented.

Table 3 – Maximum and Average Day Demands

End of Year	**Population** (Capita)	**MDD** (m^3/day)	**ADD** (m^3/day)
2020	2,774	918	569
2025	4,769	1,578	978
2030	**6,365**	**2,106**	**1,306**
2035	7,961	2,634	1,633
2040	9,557	3,163	1,960
2045	**11,153**	**3,691**	**2,288**
2050	12,320	4,077	2,527
2055	13,610	4,504	2,791
2060	15,033	4,974	3,083
2065	16,604	5,494	3,406
2070	18,339	6,068	3,761
2073	19,465	6,441	3,992

Storage Volume

Required Storage Volume

The required fire flows and total storage requirements based on the populations and demands described above have been calculated using Table 8-1 and Section 8.4.2 of the Ministry of Environment Design Guidelines for Drinking-Water Systems (2008). The results have been summarized and presented in Table 4 below and calculated using the following formula:

Total Treated Water Storage Required =
A (Fire Storage)
+ B (Equalization Storage, that is 25% MDD)
+ C (Emergency Storage, that is 25% of A + B)

Table 4 – Fire Flow & Storage Required

Planning Period	**Population** (Capita)	**Fire Flow Duration** (hours)	**Fire Flow** (L/s)	**A** (m^3)	**B** (m^3)	**C** (m^3)	**Treated Water Storage Required** (m^3)
2020	2,774	2	100	720	230	237	1,187
2025	4,769	2	130	936	395	333	1,663
2030	**6,365**	**3**	**150**	**1,620**	**527**	**537**	**2,683**
2035	7,961	3	170	1,836	659	624	3,118
2040	9,557	3	190	2,052	791	711	3,553
2045	**11,153**	**3**	**210**	**2,268**	**923**	**798**	**3,988**
2050	12,320	3	220	2,376	1,019	849	4,244
2055	13,610	3	230	2,484	1,126	902	4,512
2060	15,033	3	250	2,700	1,244	986	4,930
2065	16,604	3	260	2,808	1,374	1,045	5,227
2070	18,339	4	270	3,888	1,517	1,351	6,756
2073	19,465	4	280	4,032	1,610	1,411	7,053

Based on the above, a water tower constructed to service the 2073 population would result in stored water being unused for over 12 days under the existing average day demand, resulting in potential water quality and operational issues. Given this, a shorter design period is recommended which will allow adequate volume turnover in the near term. The proposed tower will be sized based on the year **2045** population of **11,153** resulting in a storage volume of **3,988m^3.** In addition, this shorter design period will allow the municipality to plan for a second storage facility in the mid-term that will provide system storage redundancy and more accurate long-term planning of storage volume. The water quality will be maintained by way of appropriate circulation piping and management/operation methodology described in the following sections.

Design & Configuration

Operating Levels & System Pressure:

The topography of the existing and future service area ranges from approximately **505.5 to 528.0** meters above sea-level (m), requiring the minimum Hydraulic Grade Level (HGL) within the tower being set at least **565.5m** to maintain an ideal system pressure above 350 kPa (50 PSI) under MDD, confirmed through system modelling.

Observations at the existing well houses, and reflected in the system model, indicate that the water system operates at a HGL of **567.86m to 572.45m.**

Therefore, to remain consistent with the current operating conditions and to ensure adequate service to the expected future areas, it is recommended that water tower be designed with a typical minimum operating HGL of **568.0m** and highest water level (HWL) of **571m**. This high HWL results in the maximum system pressures being below the recommended limit of 700kPa (100 psi).

Further, the Tower has been designed to meet or exceed the recommendations of the MOE Guideline 8.4.2, with the equalization volume (B) being available between the Top Operating/Highest Water Level (HWL) and an elevation necessary to maintain 275 kPa (40 psi) within the majority of the system under maximum day demand. The fire (A) and emergency (C) component volumes (i.e., A + C) are available between the bottom elevation of the B volume and the elevation necessary to produce a minimum 140 kPa (20 psi) under the maximum day plus fire flow condition.

Based on the above requirements, and assuming a conceptual tower configuration as per Figure 2.0, the required volumes and elevations are illustrated on Figure 3.0 and listed in the following table.

The tower has been sized to ultimately service a population significantly larger than existing. In order to reduce operational issues in the near term, the tower will be operated at lower operating levels to reduce the excess volume on the system. Two operating conditions have been considered, 2030 and 2045 as described below.

Table 5 – Tower Volume & Operating Levels

Parameter	**Year**	
	2030	**2045**
Total Volume Required (m^3)	2,683	3,988
(B) Required Equalization Volume (m^3)	527	923
HWL (m)	**569.6**	**571.0**
A + C Required Component Volume (m^3)	2,157	3,066
LWL (m)	**561.2**	**558.7**
Base Elevation (m)	524.75m	

Expected system pressures, during maximum day demand at various points on the system are presented in the following table.

Table 6 – System Pressures

Water Level (m)		**Maximum** (PSI)	**Minimum** (PSI)
2045 HWL	571.00	**88.3**	**56.7**
2030 HWL	569.60	**86.4**	**54.9**
HGL (Typical)	568.00	**84.1**	**52.6**
2030 LWL	561.15	**74.4**	**42.9**
2045 LWL	558.68	**58.9**	**39.4**

The above expected system pressures are calculated using the Township's WaterCAD system model. As noted, the specified HWL and LWL elevations for the two design periods considered will satisfy the requirements of the MOE and provide ideal system pressures.

Draw Pipe Sizing

Given that the existing fire pump at D3 will be decommissioned and removed from the system, the maximum flow rate from the tower will be equal to the fire flow rate for the entire community, plus the maximum day demand base on the future system demand projections. Therefore, a draw pipe size of **300mm** diameter has been provided, resulting in a velocity of 2.5 to 3.6 m/s, and 0.021to 0.041 meters of head loss, per meter, as indicated in the following table.

Table 7 – Draw Pipe Sizing

Year	**Population**	**MDD** (L/s)	**Fire Flow** (L/s)	**Total Flow** (L/s)	**Velocity** (m/s)	**Losses Per Meter** (C=120)
2030	6,365	24	150	174	2.5	0.051
2045	11,153	43	210	253	3.6	0.101

Overflow Pipe Sizing

The overflow pipe is sized to accommodate the total supply capacity of the Dundalk Municipal wells, which have a maximum daily capacity of 2,817m^3/day (32.6L/s) based on the Permit to Take Water. However, if an operational error is made and all three wells operate at their maximum pumping capacity, the total instantaneous flow rate could be as high as 55.3L/s. Therefore, an overflow pipe size of **200** mm diameter has been provided, resulting in a velocity of 1.76m/s and 0.018 meters of head loss per meter.

Fill Pipe Sizing

The Municipal water supply system maximum daily capacity currently 2,817m^3/day (32.6L/s) as specified in the Permit to Take Water, however, an allowance for increase supply capacity is assumed, therefore the 2045 maximum day demand flow rate of **42.7L/s** is used to determine the required fill pipe diameter. Given this, a fill pipe diameter of **200mm** diameter has been provided, resulting in a velocity of 1.36m/s and 0.011 meters of head loss per meter.

<u>Water Quality</u>

Chlorination

The proposed water tower will be equipped with a separate chlorine room, complete with a chlorine residual sampling and and chlorine injection equipment necessary to achieve standard chlorine levels consistent with the existing DWWP and in accordance with the O.Reg. 170/03.

The chlorine residual analyzer is capable of providing continuous measurement of free chlorine, total free chlorine and pH and situated in the control room, with the sensor installed near the base of the draw pipe.

The re-circulation pump and associated piping (65mm) will re-circulate water from the base of the draw pipe back into the tank at a flow rate of 12.5 L/s, resulting in an exit velocity of 10m/s through the 40 mm nozzle. This flow rate and velocity will assist with mixing within the tank.

A 12% sodium hypochlorite solution is injected into the re-circulation flow stream by one of two chlorinators (1 duty, 1 back-up), which are situated in the control room. The point of injection is immediately downstream of the re-circulation pump. Each chlorinator has a minimum pumping capacity of 1.5L/hr, which provides a chlorine dosage of 4.0 mg/l based on the re-circulation rate of 12.5 L/s, as per the following calculation:

Sodium Hypochlorite Solution Feed Rate:

$$= 12.5\text{L/s} \times 4\text{mg/L} \div 12\% \times 10^{-6}\ \text{kg/mg} \div 1.025\text{kg/L} \times 3600\text{sec/hr} = 1.46\ \text{L/hr}$$

The re-chlorination system will be operated as required to maintain the minimum 0.25mg/L free chlorine levels within the storage tank. The analyzer will be on-line continuously. If chlorine residual levels drop below an operator selected preset level (i.e., 0.25 mg/l), the analyzer will signal the SCADA system which will activate the re-chlorination system. If the residuals continue to drop, the operator will be alarmed. Once the analyzer detects those residual levels have increased to the operator selected high preset level, it will signal the SCADA system which will turn off the re-chlorination system.

Circulation

Circulation of the system water through the Fill pipe is improved using a **150mm** turbulent jet mixing nozzle provided within the water tower. The lowest flow rate into the water tower shall be taken as 13.68L/s, equal to the flow rate from the lowest producing Well, D3. This arrangement results in an inflow to nozzle diameter ratio of 91.2, which is greater than the required 3.6. Refer to the calculations provided below.

Inflow Rate (13.68L/s) ÷ Nozzle Diameter (0.15m) = **91.2**

Further, to ensure adequate mixing, the change in water volume during the filling cycle shall be equal to 9 x d x $V1^{2/3}$, where d is the inlet diameter (**0.15m**) and V1 is the volume in the tank at the start of filling. As the tower has been designed for two future servicing scenarios, 2030 and 2045 servicing years, the estimated volume of water in the tank at the start of fill will be based on 70% full for the 2030 and 2045 design years, respectively. Based on the average flow rate of a well house high lift pump of **18.4L/s**, the required filling time is then calculated for the respective service years. Refer to Table 8 below.

Table 8 – Minimum Filling Time

Year	**Volume at Start of Filling** (m^3)	**Elevation** (m)	**Change in Volume** (m^3)	**Minimum Fill Time** (Hrs)
2030	1,878	564.96	206	4.18
2045	2,792	566.21	268	5.45

Further to this, the tank has been designed such that 20% of volume at the start of filling will be turned over (used) 1.5 to 4.1 times within one day, to ensure adequate mixing. Refer to Table 9 below.

Table 9 – Fill Cycles Per Day

Year	**ADD** (m^3/day)	**20% Volume at Start of Filling** (m^3)	**Cycles per Day**
Existing	569	376	1.5
2030	1,306	376	3.5
2045	2,288	558	4.1

Operation Control

The proposed facility will be incorporated into the existing SCADA system and will float on system pressures. Provisions will be incorporated into the SCADA system to allow control of the existing system well pumphouses based on levels in the proposed elevated tower. Water level alarms for low and high-water levels, entry, smoke and illumination failure will be provided and incorporated into the existing SCADA system.

Conclusion:

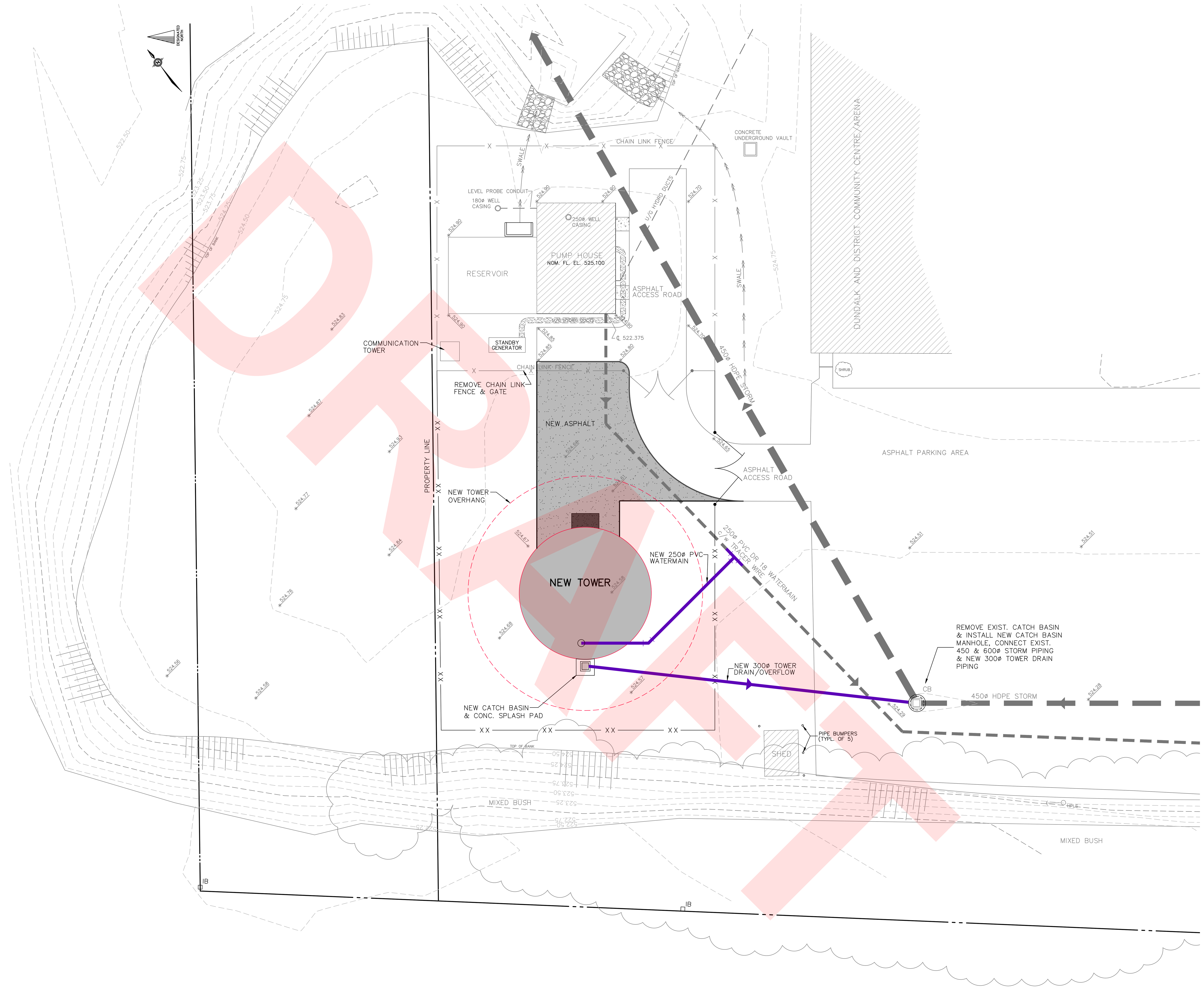
As provided, the Township of Southgate has determined that a water tower with a capacity of **4,000m^3**, and a high-water level of **571.00m** shall be constructed to service the existing and future needs of the community.

If you have any questions, please contact us.

Yours very truly,

Dustin C. Lyttle, P.Eng

Ray D. Kirtz, P.Eng



PRELIMINARY

PRELIMINARY

NOTES

THE LOCATION OF UTILITIES IS APPROXIMATE ONLY AND SHOULD BE DETERMINED BY CONSULTING THE MUNICIPAL AUTHORITIES AND UTILITY COMPANIES CONCERNED. THE CONTRACTOR SHALL PROVE THE LOCATION OF UTILITIES AND SHALL BE RESPONSIBLE FOR ADEQUATE PROTECTION AGAINST DAMAGE.

No	DATE	REVISION	INITIAL
1	JULY 2021	ISSUED FOR PRELIMINARY DESIGN	D.C.L

CONSTRUCTION OF

ELEVATED WATER TOWER

(DUNDALK)

TOWNSHIP OF SOUTHGATE
185667 GREY COUNTY ROAD #9
RR#1 DUNDALK, ONTARIO N0C 1B0

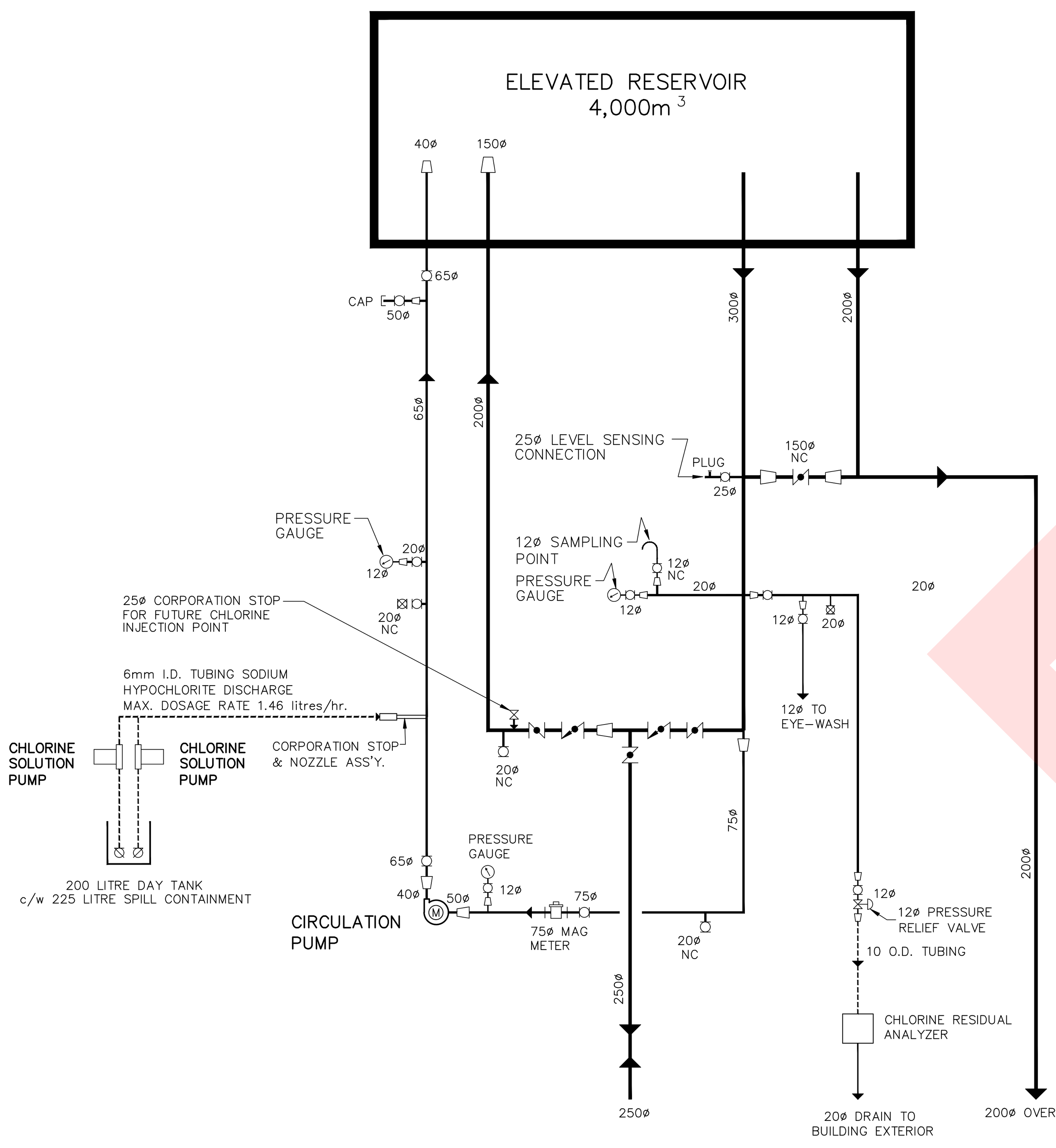
SITE PLAN

PROJECT No T4612
DRAWN BY: d.r.t. (AutoCAD)
CHECKED BY: R.D.K
APPROVED BY: D.C.L.
DATE: OCTOBER 2020

TRITON ENGINEERING SERVICES LIMITED
Consulting Engineers

SCALES
1:200
HORIZONTAL VERTICAL

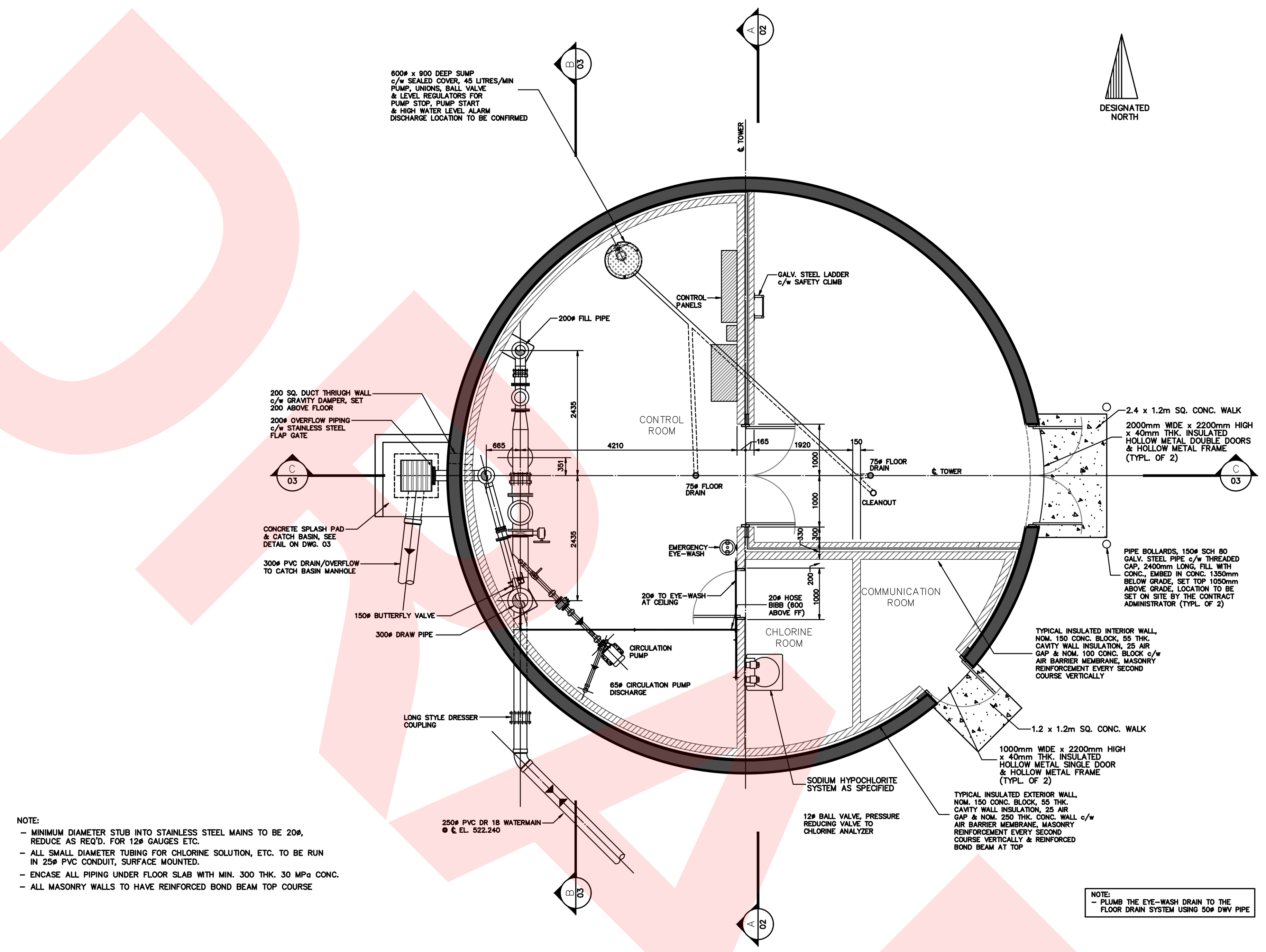
DRAWING NUMBER 01
REV. 0



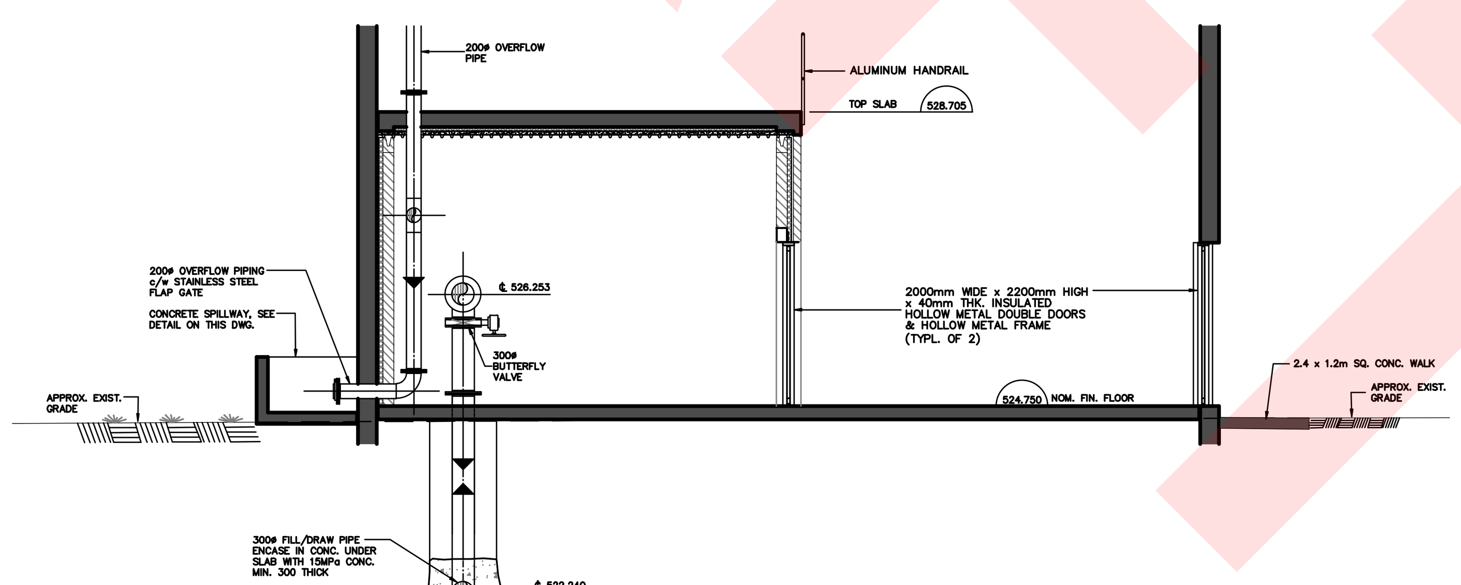
SCHEMATIC
NOT TO SCALE

LEGEND:

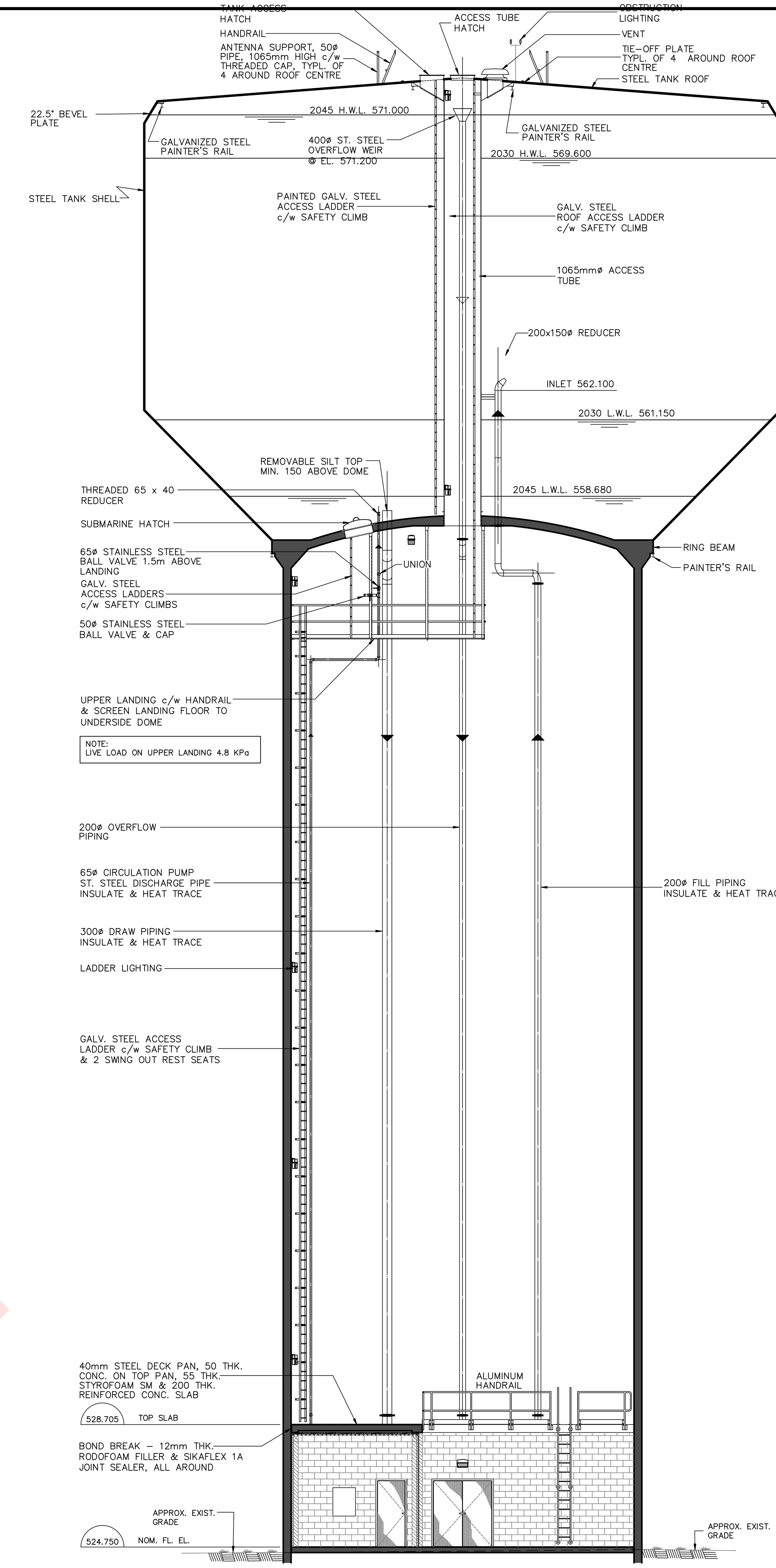
- BUTTERFLY VALVE
- SWING-FLEX CHECK VALVE
- BALL VALVE
- FOOT VALVE
- HOSE BIBB c/w VACUUM BREAKER
- NC NORMALLY CLOSED
- (M) MOTOR



MAIN FLOOR PLAN
SCALE 1:100



SECTION 02
NTS



SECTION A-A 02
NTS

PRELIMINARY

PRELIMINARY

NOTES

THE LOCATION OF UTILITIES IS APPROXIMATE ONLY AND SHOULD BE DETERMINED BY CONSULTING THE MUNICIPAL AUTHORITIES AND UTILITY COMPANIES CONCERNED. THE CONTRACTOR SHALL PROVE THE LOCATION OF UTILITIES AND SHALL BE RESPONSIBLE FOR ADEQUATE PROTECTION AGAINST DAMAGE.

No	DATE	REVISION	INITIAL
1	JULY 2021	ISSUED FOR PRELIMINARY DESIGN	D.C.L

CONSTRUCTION OF

ELEVATED WATER TOWER

(DUNDALK)

TOWNSHIP OF SOUTHGATE
185667 GREY COUNTY ROAD #9
RR#1 DUNDALK, ONTARIO N0C 1B0

MAIN FLOOR PLAN & SECTION & PROCESS SCHEMATIC

PROJECT No T4612
DRAWN BY: d.r.t. (AutoCAD)
CHECKED BY: D.C.L.
APPROVED BY: R.D.K.
DATE: OCTOBER 2020

TRITON ENGINEERING SERVICES LIMITED
Consulting Engineers

SCALES
HORIZONTAL 1:200 VERTICAL

DRAWING NUMBER 02
REV. 0